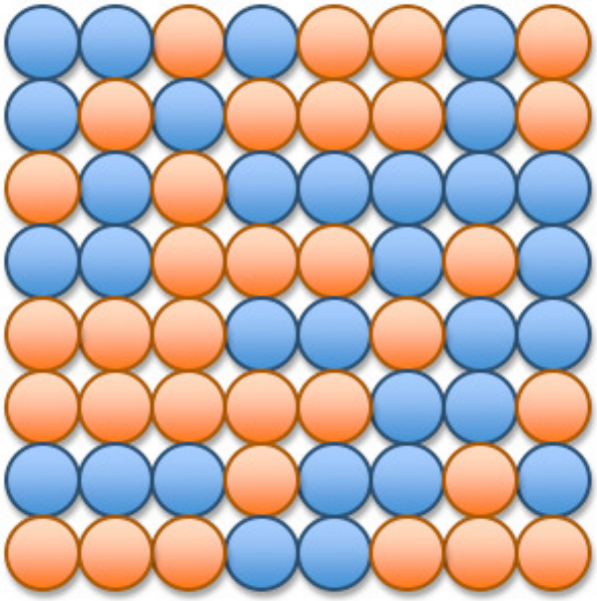


UNIT 11B

The Internet ctd…

Last Lecture

- Internet system
  - Hardware
  - protocols
  - IP addresses
- Servers
  - What do they do?
  - How to configure them?
- Emails
  - How they work

Questions?

- Who owns the internet?
- What is the purpose of a router?
- Does a router knows you are sending email or a pciture?
- How does internet handles multiple size files?
- Is the internet a circuit-switch system like the telephone system?

Internet as a packet switched system

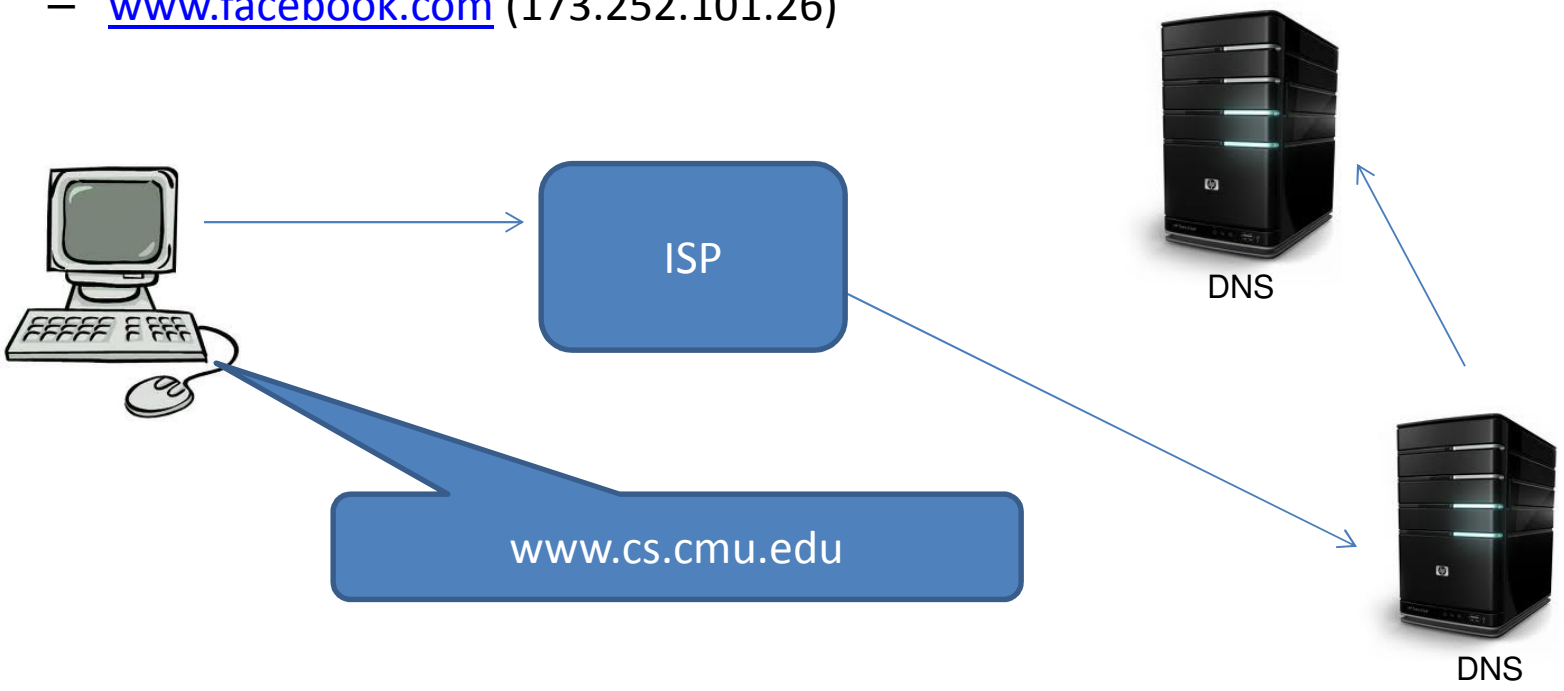
- Design internet as a packet switched system
- Capacity of the internet is only limited by data traffic
- Limit the size of a packet to n bytes (n<1500)
- Packets don’t have to arrive in sequence or at the same time or even the same route

Internet as a system

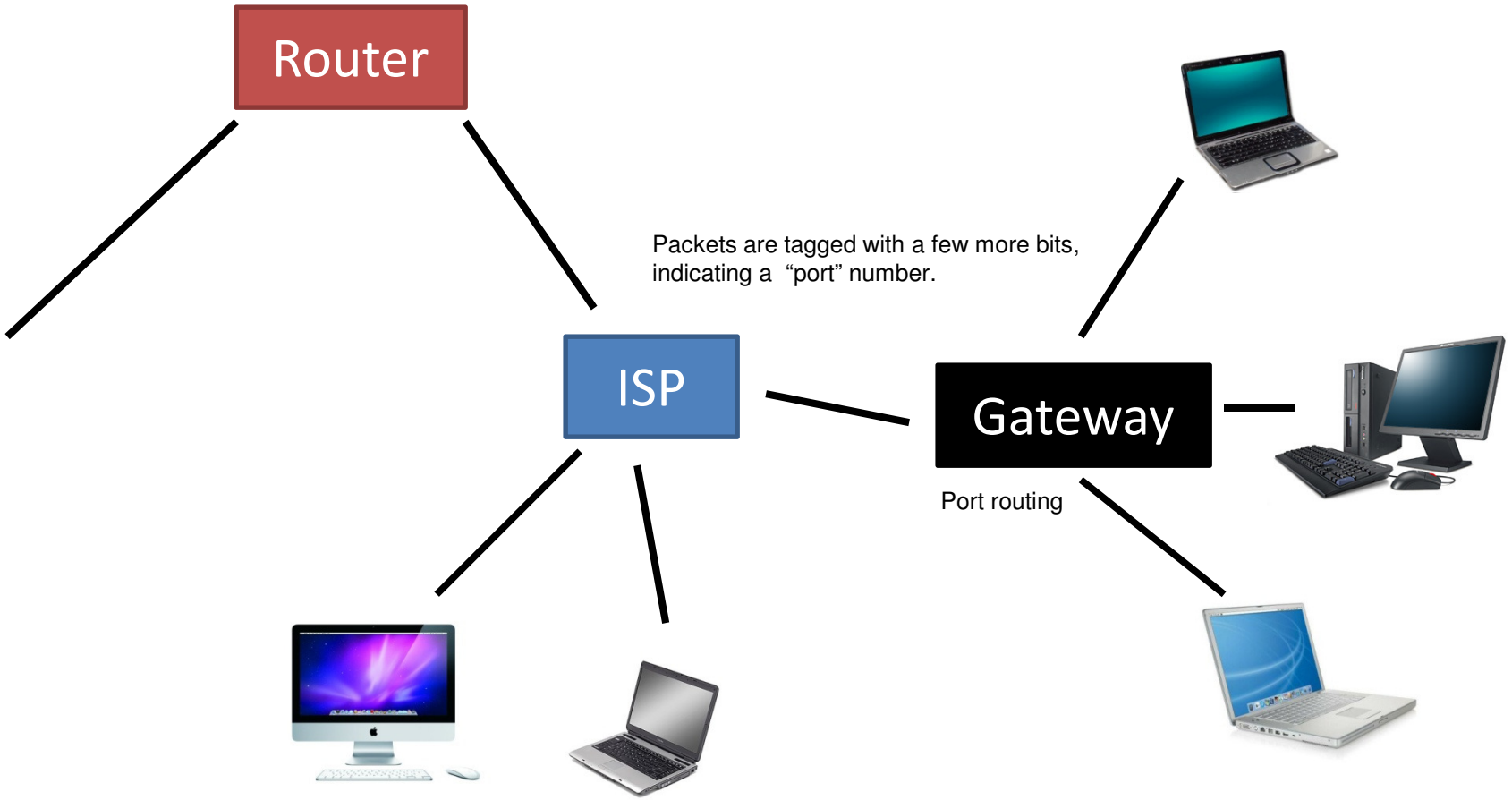
- Core elements and edge nodes

Domain Name servers

- The service that ties domain names to IP addresses
  - www.cmu.edu (128.2.42.52)
  - www.google.com (173.194.75.147)
  - www.facebook.com (173.252.101.26)



Network Address Translation (NAT)



Passing packets

Routing messages

- Routers do not know anything about the packets they are passing
- Routers can check the integrity of a packet by testing for errors in the packet
  - Missing bits
  - What can router do if it detects an error?
- Routers can also “buffer” packets
- Packets are formatted according to Internet Protocol (IP)

Protocols

Protocols

- Agreement between communicating parties
  - Web (HTTP, SSL)
  - Email (SMTP, POP3, IMAP)
  - File Transfer (FTP)

- protocols
  - define format
  - order of messages sent and received among network entities
  - actions taken on messages receipt

Quiz

- Who controls the internet?
- Can anyone join internet?
- Is it possible that an email message can get lost?

Maintaining Reliability

- Use a higher level protocol to deliver messages reliably
  - Individual packet delivery may be unreliable
- Transport Control Protocol (TCP)
  - Higher level protocol to assure reliability
- TCP/IP

Reliable Communication with TCP

- Suppose Alice and Bob are the TCP implementations of two computers.
  - Alice is asked to send a message to Bob.
  - Alice breaks the message into several packets.
    - Each packet includes parity information, so Bob can check it for accuracy.
    - Packets are sent via IP.
  - Bob receives the packets.
    - If Bob is missing a packet or receives a corrupt packet, he can request retransmission.
    - If the packet is OK, Bob sends an acknowledgement.
  - If Alice doesn't get an acknowledgement, she will retransmit.
  - Bob assembles the incoming packets in order and provides the message to the appropriate application.

Other protocols

- Live streaming of data
  - Video
  - VoIP
- User Datagram Protocol (UDP)
  - a simple transmission model with a minimum of protocol mechanism
  - No “handshaking”
  - Error checking is not necessary or done by the application

quiz

- Can entire internet fail for some reason?

- Can your computer fail to send a message?

How web pages work

Hypertext Transfer Protocol(HTTP/S)

- Retrieves documents(in HTML and other formats) over TCP using port 80
- Can also send form data to the server
- Support multiple requests per connection
- HTTPS = HTTP + TSL/SSL (secure socket layer)

Example: Web page Delivery

- A Web page is identified by a Uniform Resource Locator(URL)
- protocol://host address/page
- An HTTP Request
  - http://www.cs.cmu.edu/~15110/index.html

Example: Web page Delivery

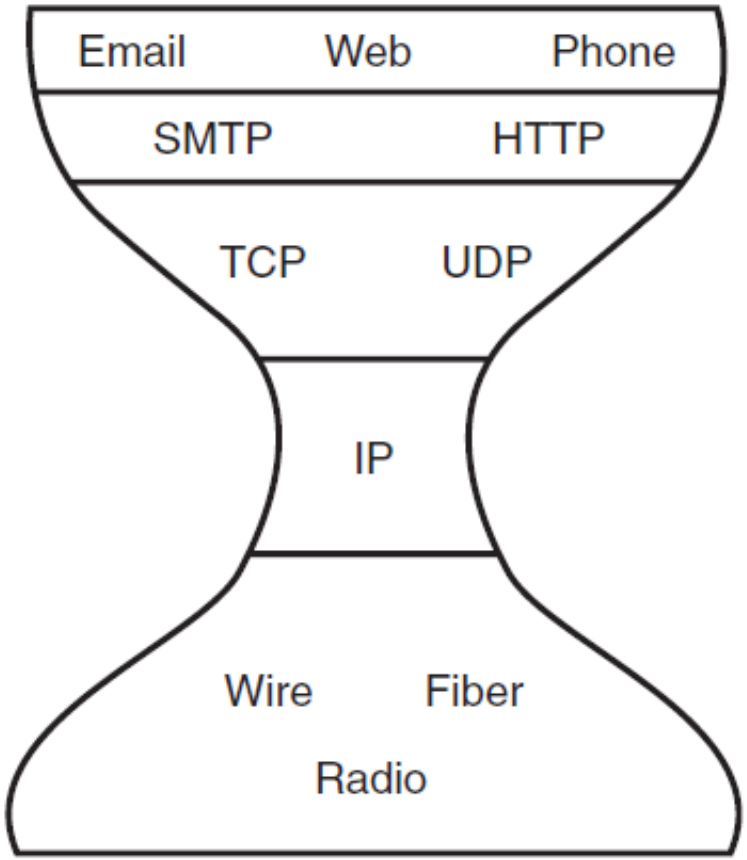
1. Web browser extracts the name of the machine and gets it translated to an IP address (e.g. 128.2.217.13)
2. Establishes a TCP connection to port 80 at 128.2.217.13
3. Constructs a message

   GET /~15110/index.html HTTP/1.1
4. Sends the message to server using services of TCP/IP
5. Web server locates the file and send a response back to browser using services of TCP/IP
6. The connection is terminated.

Email protocols

- Email protocols governs the communication between mail servers and clients
- SMTP
  - user-level client mail applications typically use SMTP only for sending messages to a mail server for relaying
- POP3
  - allows email client software to retrieve email from a remote server
- IMAP
  - newer protocol and oriented toward a "connected" mode of operation

Internet architecture



Source: blown to bits

Back to IP Addresses

IP Addresses (IPv4)

- Computers on the Internet are assigned an IP Address consisting of four numbers between 0 and 255 inclusive

  ____ . ____ . ____ . ____

  Example: 128.2.13.163

- This means that each part of the address is an 8-bit value, and an IP address is 32 bits. Hence, it supports up to 2^{32} computers on the network at the same time.

- ISPs can reassign IP addresses dynamically.

IPv4 Address Assignment

- The original IPv4 had several classes of addresses that could be decomposed into a network and host part
  - Class A **0** + 7-bit network + 24-bit address
    Accommodates up to 2^{24} unique IP addresses in a company or location.
  - Class B **10** + 14 bit network + 16-bit address
    Accommodates up to 2^{16} unique IP addresses in a company or location.
  - Class C **110** + 21-bit network + 8-bit address
    Accommodates up to 2^{8} unique IP addresses in a company or location.

IPv4 Address Assignment

- In 1993, the Internet switched to classless internet-domain routing.

- In this scheme, the network part is an arbitrary length prefix of the address, such as 10.10.1.32/27, which has a 27-bit network part and a 5-bit host part (so there can only be 32 machines on that network).

New IP (IPv6)

- IPv6 uses 128-bit addresses, which implies 2^{128} (3.4×10^{38}) unique computer addresses ,($4.8 * 10^{28}$ addresses per person)
- Allows for many more devices (cell phones, video game machines, appliances, automobiles, etc.)
- Designed to deal with the approaching use of all available addresses in IPv4.
- IPv6 also follows classless routing, but the standard subnetwork size is 64-bits.

Questions?

- Can entire internet fail on its weight?
- What would be an alternate model?
- How has internet changed humanity? Opportunity?
- How do we define intelligence?

Bonus Slides

You will not be tested on these slides

Internet layers

Layering Abstractions

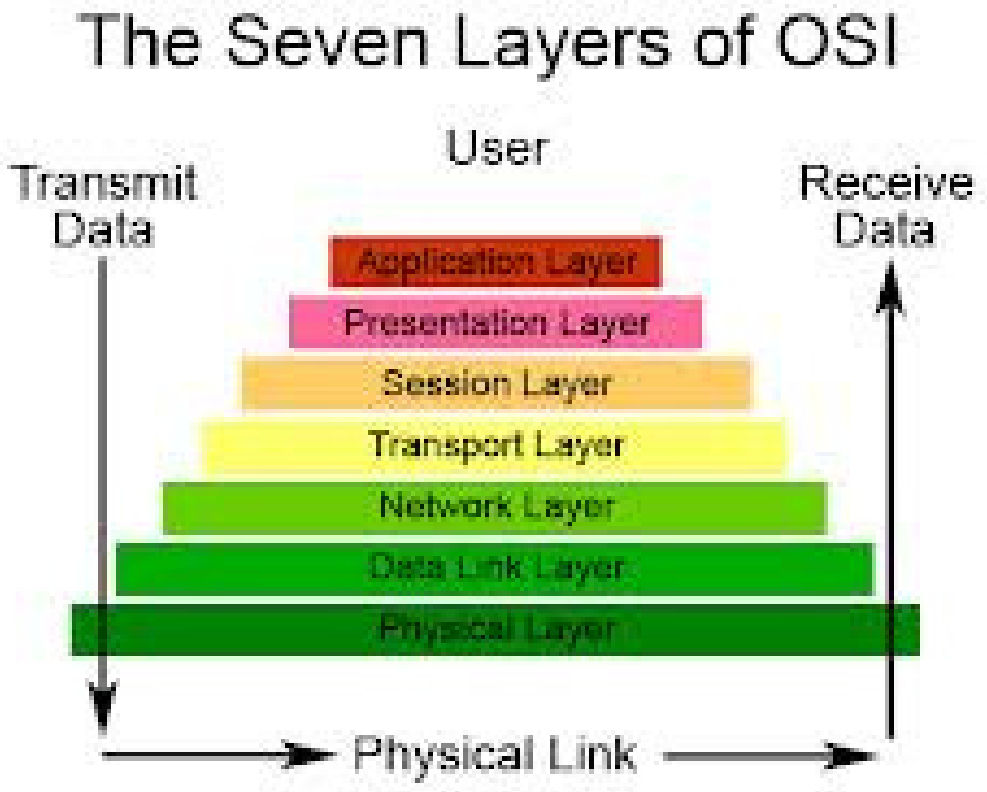
- It is often useful to divide large systems into layers
  - Higher layer uses a lower layer as a service
  - Lower layers are implemented independently from higher layers
  - Interface between two layers needs to be specified

- Example: Dice game uses `roll`

  `roll` uses `rand`

  `rand` uses some LCRG method

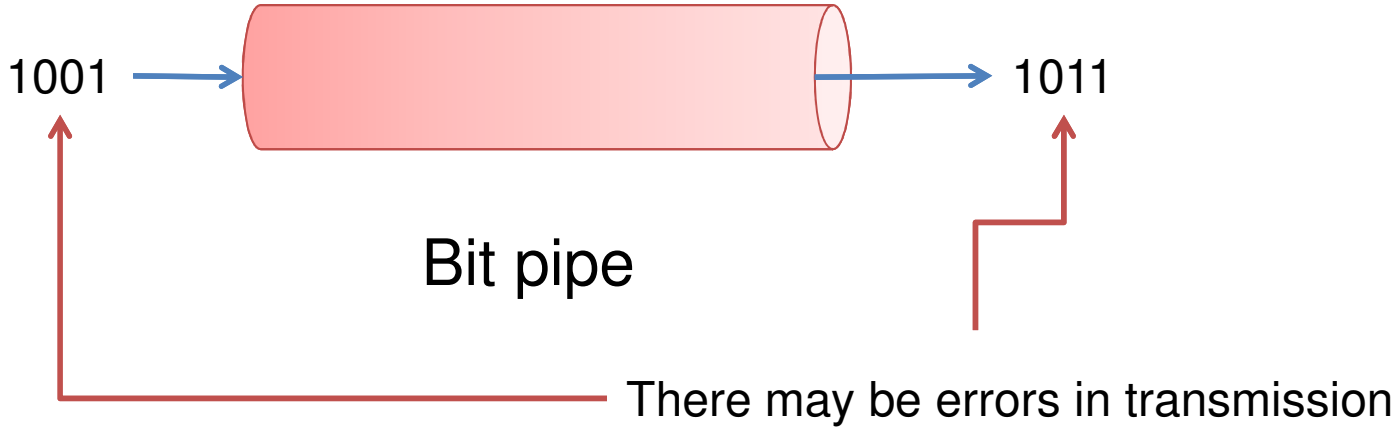
Open system interconnection



Source: Washington.edu

Link Layer

Physical Links



Link Layer

Data Links

Network Layer

- The link layer enables us to transmit messages from node A to node B, only if these two are connected by a physical link.

- In networks other than LANs, majority of nodes are not directly connected.

- Network layer is responsible for delivering messages from their source to destination.
- Key functions:
  - Create a universal addressing scheme for all network nodes
  - Deliver messages between any two nodes in the network

Transport Layer

- Internet Protocol (IP)
  - Delivers packets to IP address
  - Best effort delivery
- Transport Control Protocol
  - Creates a reliable bi-directional stream (source address/port and destination address/port)
    - acknowledgements, resend, reassembly in correct order,
    - error detection
    - connection must be opened and closed
    - flow/congestion control

Transport Layer